HUGHES

OPERATION AND MAINTENANCE MANUAL

HUGHES MODEL MCW-550 CONSTANT VOLTAGE WELDING POWER SUPPLY

Revision No. 2 July, 1972

ELECTRONIC WELDING EQUIPMENT

HUGHES

HUGHES AIRCRAFT COMPANY
Industrial Products Division
Production Equipment Department
2020 Oceanside Boulevard • Oceanside, California 92054

CODE IDENTIFICATION NO. 00816

Warranty

Applicable to Production Equipment sold by the
Industrial Products Division of Hughes Aircraft Company

1. Except as may be otherwise provided in paragraphs 2 and 4 below, any production equipment or parts thereof returned within one year from the date of its shipment and found by Hughes to be defective in material or workmanship, will be repaired or replaced free of charge. However, where Purchaser prefers to effect repairs and replacements at its own expense and risk, a credit or replacement will be issued for any part for which Purchaser at its expense has obtained a replacement from Hughes, provided that said part is found by Hughes to be defective in material or workmanship and is returned within one year from the date of shipment of the equipment into which it was incorporated. Such credit shall be at the price charged Purchaser for the replacement part. Unless Purchaser requests a credit at the time it returns the part, a replacement part rather than a credit will be issued.

2. Repair workmanship performed and parts repaired or replaced free of charge by Hughes are warranted against defective material and workmanship. To qualify for such warranty the repaired or replaced equipment or part must be returned to Hughes either within the ninety day period immediately following date of shipment or within the remainder of the one year warranty period on the original equipment, whichever period is longer, and must be found by Hughes to be so defective.

3. Estimated repair and replacement charges will be submitted to Purchaser for equipment or parts thereof not covered by any warranty set forth herein. Upon receipt of Purchaser's approval thereof, necessary repair and replacement work will be promptly accomplished.

4. Repair and replacement work performed by Hughes at Purchaser's expense, and parts sold separately from the equipment for which they are a component are warranted for a period of ninety days from the date of shipment to be free from defects in material and workmanship, and will be repaired or replaced free of charge when the item repaired and/or replaced or the part sold is returned within the warranty period and is found by Hughes to be so defective.

5. Where repair, replacement or credit is not allowed for any returned equipment or part, and approval of repair and replacement work is not received within sixty days from the date estimated charges therefore are submitted, such equipment or part will be returned to Purchaser at its expense plus a handling and inspection charge of five percent of the price of such item.

6. Equipment or parts which have been subjected to accident, alteration, misuse, abuse, tampering or operation other than as specified and printed, are not covered by the warranties specified above and no repair, replacement or credit will be allowed with respect thereto.

7. Subject to the provision of the "Patent Indemnity" clause of its Sales Terms and Conditions, Hughes also warrants that it has the right to sell its production equipment and parts thereof, that Purchaser shall have and enjoy quiet possession of such equipment and parts as against any lawful claims existing thereagainst at the time of the sale, repair or replacement thereof by Hughes, and that said equipment and parts at the time of sale, repair or replacement by Hughes are free from any charge or encumbrance in favor of any third person.

8. The warranties set forth herein are restricted to the original Purchaser. The foregoing constitutes Hughes' entire warranty, express, implied or statutory, with respect to its production equipment, parts thereof or therefor, and repair thereof, and states the full extent of Hughes' liabilities for breach of warranty and for damages, whether direct, special or consequential, resulting from any such breach. No change whatsoever to such warranties shall be binding upon Hughes unless in writing and signed by a duly authorized Hughes' representative.

EXCEPTION:

Electrodes and heater thermocouple cartridges (expendible items) are warranted against defective material and workmanship for a period of 30 days immediately following date of shipment.

HUGHES

OPERATION AND MAINTENANCE

MANUAL

HUGHES MODEL MCW-550
CONSTANT VOLTAGE
WELDING POWER SUPPLY

SERIAL NO._____

Revision No. 2 July, 1972

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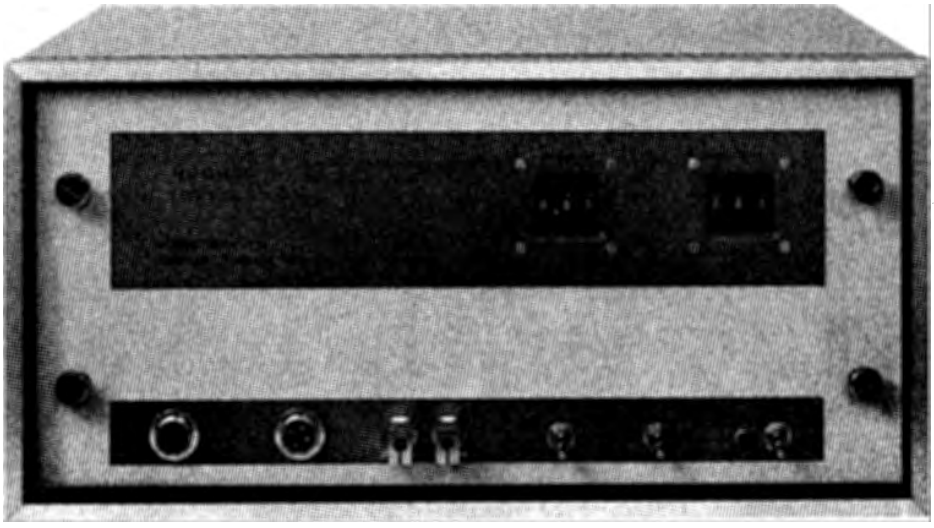

The Hughes Model MCW-550 Constant Voltage Welding Power Supply

SECTION I

DESCRIPTION – MCW-550

The MCW-550 Power Supply is an all solid state CONSTANT VOLTAGE Power Supply designed specifically for parallel-gap (series) welding of integrated circuit package leads to printed circuit boards, and fine ribbons & wires to thin films. It may also be used for conventional opposed-electrode resistance welding of virtually any type of small assembly.

DESIGN FEATURES

Constant Voltage Output - The MCW-550 provides a constant voltage output (as preset on the digital dials) which assures uniformity of welding results over a broad range of variables in materials, thickness, cleanliness and electrode tip variations.

The power supply delivers a varying current output that automatically compensates during the welding cycle for variations in resistance occurring in or across the weldment and will at all times (within the current range of the power supply) maintain the constant voltage that has been preset on the digital dial. The constant voltage will assure that the current density remains constant during the weld cycle.

The power supply's ability to compensate for load changes is nearly instantaneous and can be assumed to be faster than one hundred micro-seconds in most cases.

The constant voltage output will remain regulated within twenty-five millivolts throughout the range of dial adjustment.

Uniform Square Wave - Pure DC Pulse Output - At all output levels from minimum to maximum a uniform square wave pulse is obtained that is easy to observe and readily comparable from time to time for purposes of calibration or quality control of the power supply equipment.

The DC pulse is obtained from an electro-chemical source (nickel cadmium cells) providing a pure DC source that is unaffected by AC line fluctuations or transients.

Wide Range Timing Control with Three Range Selection on Digital Dial Control - Timing control is effected with three digital thumbwheel dial controls on the front panel. Three ranges are covered from 1 - 99, 10 - 990, and 100-9900 milliseconds.

Weld timing settings are easily and accurately adjusted by an inexperienced operator.

Automatic Recharge of Battery Supply - An automatic charger is incorporated to maintain the battery voltage within very close tolerances at all times.

Under standby conditions, the automatic charger will maintain the battery within plus or minus .10 volt of a nominal value. Under welding conditions, the charger will turn on upon demand after each weld when operating at high discharge levels.

Under most circumstances, the energy removed from the battery after each weld is replaced within one second. (See duty cycle table for complete capabilities of system.)

Completely Solid State - All control and power circuitry is solid state. No warm up time is needed. Timing and power output from the beginning to the end of a production work day will be uniform.

Illuminator Lamp Power Integral - A power supply and power switch is incorporated in the front panel with outlet receptacle to operate a standard Nicholas illuminator.

Vacuum Port Outlets - The front panel incorporates a power switch and has outlet ports for vacuum hose connections. This switch is marked Auxiliary on the front panel and may be used for other purposes.

Auxiliary Receptacles - 115 volt AC duplex receptacle is provided at rear of chassis for convenience outlet.

SECTION II

OPERATION – MCW-550

CONTROLS

Operation of the Model MCW-550 Constant Voltage Welding Power Supply is extremely simple. There are only two adjustable controls, Weld Voltage and Weld Duration.

In addition to the main power switch, there is also an Illuminator lamp switch and an auxiliary power switch (connected if a vacuum pump is incorporated within the power supply or other accessories). An external vacuum pump may be connected to the front panel power switch with hose take off thru the front panel ports if no integral pump is installed.

CONNECTION

Prior to first energizing the power supply, connect the weld head to the front panel receptacle with either cables or gold-plated copper bus bars as supplied for Hughes weld heads. When using Hughes Model VTA-66 weld head, connect 4 pin plug from head to the "Voltage-Fire" receptacle.

If other Hughes welding heads having 2 pin plugs (such as Model VTA-60, VTA-62, VTA-64, or VTA-66-MA) are used with this equipment, some provision must be made to connect the actuator firing circuit and the voltage feedback circuit to the Voltage-Fire receptacle.

WARNING – SPECIAL NOTE:

IT IS IMPERATIVE that the feedback voltage wires connecting from the weldhead electrodes to pins in the plug going to the Voltage-Fire receptacle be connected with the proper polarity.

WHICHEVER ELECTRODE IS POSITIVE MUST BE CONNECTED TO PIN 1 in the plug to the Voltage-Fire receptacle. THE NEGATIVE ELECTRODE MUST BE CONNECTED WITH A FEEDBACK WIRE TO PIN 2 in the Voltage-Fire plug.

With dual head systems, be sure to observe polarity marking on cables which will have RED dots indicating the positive cable. The corresponding positive terminal on a VTA-66 or VTA-90 weld head will also have a RED dot on the end of the positive stud.

DO NOT ATTEMPT TO OPERATE THIS POWER SUPPLY WITHOUT THE VOLTAGE FEEDBACK WIRES BEING PROPERLY CONNECTED FROM THE WELDING ELECTRODES TO THE FRONT PANEL "VOLTAGE-FIRE" RECEPTACLE.

TYPICAL OPERATION

Set "Weld Voltage" thumbwheels to approximately .30 volts. Set "Weld Duration" to 5 milliseconds. If a VTA-66 weld head is being used, set for 4 lbs. pressure and electrode gap of .020". Test welds should be made starting from these settings. Using the middle thumbwheel of the voltage control, increase settings in increments of .10 volts until some visible welding results occur.

Optimum welding results can be obtained by varying weld duration and electrode force and gap settings. Further refinements can be made by adjusting the third voltage control thumbwheel for variations from .01 volts and up.

NOTE The power supply makes no audible sound when discharged.* At lower power levels, little or no effect will be noticed upon the materials being welded.

DO NOT OVERPRESSURE the electrodes in an attempt to "fire" the welder.

Increase voltage and/or time in small increments between test welds until satisfactory results are observed.

CAUTION The MCW-550 power supply will deliver current to the limit of its ability in order to produce the preset voltage. Since this current may exceed 800 amperes, extreme care must be taken to prevent the electrode gap from shorting. Damage to the electrodes will be immediate if the power supply discharges with the electrode gap set at zero.

Avoid setting the weld voltage to a high level and long weld durations at the same time. Weld voltage settings of over ONE VOLT combined with weld duration settings greater than 100 milliseconds will produce extreme heat at the electrodes.

Most microcircuit welding applications will be within the range of .50 - .85 volts setting and 5 - 15 milliseconds weld duration, or .20 - .50 volts at 50 - 350 ms duration.

DO NOT EXCEED A VOLTAGE SETTING OF .50 VOLTS IN COMBINATION WITH TIME DURATIONS BETWEEN 250 - 500 MS FOR NORMAL WELDING.

NEVER discharge power supply with very low resistance material beneath electrodes, such as heavy copper, brass or steel plates.

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* *Sonalert audible indicator available from factory installed in original equipment on order or also available as field mod kit.*

SECTION III

ELECTRICAL & MECHANICAL SPECIFICATIONS

MCW–550

TYPE OF POWER SUPPLY:
Constant voltage - direct current - square wave output.

WELDING PULSE CONTROLLED RANGE:
Time Duration: Adjustable from 1 - 9900 milliseconds in three ranges.

Low Range: 1 - 99 milliseconds

Middle Range: 10 - 990 milliseconds

High Range: 100 - 9900 milliseconds

Voltage Amplitude: Adjustable from .01-1.99 volts.*

**Maximum controlled voltage range is limited to load conditions. With 2 milliohm load, maximum voltage may not exceed 1.30 volts.*

CONSTANT VOLTAGE REGULATION:
Will remain within 25 millivolts throughout adjustable range.

MAXIMUM WELD CYCLE POWER:
Operating into a 2 milliohm load, maximum watts per weld cycle will be approximately 850.

INPUT POWER REQUIREMENTS:
105-125 volts AC single phase, 50-60 cycle.

Average power in standby is 75 watts.

Maximum power-line demands will not exceed 3 amperes.

MECHANICAL SPECIFICATIONS:
Weight: 65 lbs. net
Height: 10-1/2"
Width: 20"
Depth: 13"

VENTILATION:
Forced air - Muffin fan

SECTION IV

MAINTENANCE – MCW-550

Batteries: The electrochemical battery source consisting of four nickel cadmium cells, is the only component in the power supply that requires occasional inspection.

These cells, when originally installed at the factory, have a preconditioning charge and the liquid level has been set to approximately the top of the plate separators (observed when the power supply has been OFF for a period not less than eight hours).

Under normal microcircuit welding conditions, this battery should require a minimum of care.

If the power supply is operated at higher power levels and near maximum duty cycle capabilities, then it is possible that the cells will occasionally vent moisture and over a period of several months they may require the addition of small quantities of distilled water. Holes in the side of the battery retainer allow observation of the liquid level within the cell. The cells have a considerable latitude of electrolyte level. Water need not be added unless the liquid level falls below the visible area of inspection in the upper inspection hole.

See pages 9, 10 and 11 for detailed instructions on battery care.

SPECIAL NOTE

When adding water, ALWAYS USE DISTILLED WATER. Also, use extreme care when removing the vent plugs in the top of the cells. These pressure vent plugs are set to relieve at approximately 2 to 8 lbs. pressure, under normal operating conditions. To add water, these vent plugs rotate counter-clockwise approximately 1/4 turn. It usually requires a pair of pliers to loosen these vents. USE EXTREME CAUTION not to short the cell terminals with the pliers. Preferably use insulated pliers.

Automatic Charger: The battery will normally be maintained at the correct degree of charge by an automatic system that senses the battery voltage and holds this voltage within very close tolerances. When the equipment is turned off, the battery should read 5.0 volts total or 1.25 volts per cell. Under operating conditions, the battery will read approximately 5.80 volts maximum with a minimum near 5.70 volts.

Additional Notes: A white powder residue may form around the inside of the vent caps. This is a result of the natural venting action and is normal to the operation of the cells. The cells contain NO ACID and DO NOT give off noxious gasses or corrosive fumes.

Calibration of WELD VOLTAGE

The weld voltage circuit is normally calibrated at the factory and under most conditions should remain constant for the life of the equipment.

If some components on the printed circuit board have been changed during service or if it is desired to check this voltage, proceed as follows:

1. Set WELD VOLTAGE thumbwheels to .10 volts output.
2. Set WELD DURATION to a suitable time for making a sample weld.
3. Connect a storage oscilloscope across the welding electrodes.
4. Perform a typical weld and observe voltage across electrodes.

   WELD VOLTAGE should be .10 volts. If not, adjust R28, which is the Left Hand 200 ohm trim pot when observing the circuit board from the component side.

5. SET WELD VOLTAGE to 1.0 volts and repeat above procedure observing weld voltage across the electrodes. If weld voltage is not 1.0 volts, adjust the 1000 ohm trim pot, R26, which is the Right Hand trim pot on the circuit board.
6. If either of the high or low trim pots were changed, it may be necessary to go back and repeat the procedure with each trim pot again since there is a small amount of interaction between the pots.

CONSTANT VOLTAGE CHECK

After the above weld voltage has been checked or adjusted and while still observing the weld voltage at the electrodes, make a typical weld on some commonly welded materials at a fixed voltage setting. Then make several re-welds or insert additional thickness of materials. The voltage at the electrodes will remain constant.

TIMING CALIBRATION - Normally fixed at factory.

If the printed circuit board is replaced or if Q3 is changed, then CT1 and CT2 trimming capacitors will have to be corrected. To obtain the most accurate timing, set 90 milliseconds on the LOW range (.0) and trim CT1 for nearest value to 90 MS. Repeat process on middle range (0) while set at 900 MS and trim CT2. The output of the MCW-550 unit should be operating WITH NO LOAD while making these timing adjustments. Scope observations may be made across the electrode tips with an insulating pad beneath the tips to prevent current flow.

SERVICE INFORMATION – NICKEL CADMIUM BATTERIES

The following information will be helpful in determining the condition of an MCW-550 battery and explain means to maintain the battery properly.

The liquid level of each cell, as observed through the ports in the retainer case, is a reasonable indication of the degree of charge only if you know what the past operating conditions have been (the last 6 - 8 hours of operation) and in some cases only after observing another 6 - 8 hour period of operation.

FACTORY CONDITIONING

The liquid level (electrolyte) is adjusted at the factory to approximately 1/16" over the top of the plate separators while the unit is turned off and only after the unit has been off for a period of 12 hours or longer.

Prior to the 12 hour OFF period, the unit would have been in operation for a period of time that was sufficient to completely charge the battery to the set level. (The set level is 5.75 - 5.80 volts, after unit has been ON one hour.)

DETERMINING DEGREE OF CHARGE

To determine that the battery is adequately charged (for units No. 131 and up) the MCW-550 should be turned on and left in a standby condition for approximately one hour. After this period of time the battery should be charged to the maximum level as previously set at the factory (assuming that the unit had not just previously been subjected to an extremely high duty cycle at high power levels).

The battery voltage should be between 5.75 and 5.80 volts as measured with either a digital voltmeter or a 1/4% accurate meter. This voltage measurement is extremely important - do not trust a typical multimeter. The liquid level after several hours in standby or after operating should be approximately 1/8" to 3/8" over the top of the plate separators. It is normal for the liquid level to rise during operation and to fall back to plate level during OFF periods.

If, after one hour of standby time, the liquid level is still at plate level or below and if the battery voltage is still below 5.75 but continuously rising slowly, then it can be assumed that the battery was in a low state of charge when first turned on. The power supply should be left in the standby condition until the battery voltage ceases to rise and becomes steady at 5.75 - 5.80. If the battery voltage were to stop at some point below 5.75, a very slight clockwise increase of R49 (pot adjacent near positive battery cable on chassis) would bring the voltage up.

DO NOT USE A GROUNDED VACUUM TUBE VOLTMETER WHILE MEASURING BATTERY VOLTAGE.

DETERMINING CHARGE OR NEED FOR WATER.

To accurately set the liquid level (or to determine the need for addition of water) the battery must be observed AFTER the unit has been OFF for a period of 8-12 hours (following the previous day or period when you know that the unit had been on for a period of time necessary to reach the maximum set charge level of 5.75 - 5.80 volts).

The liquid level should be approximately 1/16" over the plate separators (all cells should be nearly the same). If the liquid level is more than 1/4" below the top of the plate separators, additon of distilled water is needed. If the liquid level is more than 1/4" above the plate separators, it would be best to remove some electrolyte down to the 1/16" over plate separator level (to minimize spitting) although this is not necessary for satisfactory operation. If the liquid level is maintained excessively high, considerable venting action will occur which will result in excessive powdery residue around the vent plugs.

The use of plastic caps (supplied by the factory upon request if not already installed on unit) pressed down tightly over the vent plugs will minimize the spreading of the vented residue over the top of the battery.

MCW-550 UNITS NOT IN USE FOR SEVERAL WEEKS OR MORE – LIQUID LEVEL

In some cases in units which have not been operated for several weeks or longer, the battery liquid level before turn on may be below the upper inspection port and still above the lower port and not be visible. If this appears to be the case, tilt the power supply on either side until the liquid level can be observed. If this is the case and the level is between ports, the MCW-550 should be energized for several hours in standby and observe that the liquid level rises to approximately the level of the plate separators. In most cases it will return correctly. If, after several hours of operation, the liquid level does not come all the way up, turn unit OFF. Twelve hours or more later, preferably the next day, add distilled water to bring level up to just over plate separators (1/16").

UNITS – SERIAL NO. 101 - 130

All previous information applies to these units (No. 101 through 130) except that the battery voltage is not fixed at 5.75 volts. The battery charger cycles between 5.25 and 6.00 volts, and usually turns on only upon demand when welds are being made.

To check that battery is at maximum charge or to bring the battery up to this point, the MCW-550 should be operated at a low duty cycle and preferably at low power settings. Under normal conditons, when the battery is charged adequately, several welds can be made and the battery voltage will slowly fall with each weld. At a

voltage near 5.6 - 5.7 volts, the charger will turn on and return the battery to approximately 5.95 volts.

This battery voltage will then taper off slowly until sufficient energy has been withdrawn to reduce the battery voltage to the 5.6 volt level and again the charger will turn on automatically and repeat the charge cycle.

DETERMINING CHARGE STATE-SERIAL NO. 101-130

After operating at a low duty cycle for a period of one-half to one hour, and if the battery voltage has repetitively risen to 5.85 - 5.95 volts and fallen back to 5.50 volts plus or minus 1/4 volt, it can be assumed that the battery is at the nominal charge level.

The level of the liquid should be 1/8" to 3/8" over the plate separators during periods of operation. After it is known that the unit has operated for a period of several hours and presumably reached a well charged condition, then twelve hours later (or preferably the next day) before the unit is turned on, the liquid level should be approximately at plate separator level or up to 1/8" over. If the level were to be considerably less than this (1/4" below plates or more) distilled water should be added to bring the level up.

While monitoring the charge voltage cycle, if the maximum charge voltage does not fall within the range of 5.85 - 5.95 volts, then adjust R49 pot on chassis near positive cable to obtain this setting. ADJUST THIS POT VERY CAREFULLY. A very slight clockwise increase will increase the charge voltage considerably.

ADDITIONAL NOTES

1. When first inspecting a unit for battery condition, always check that the fuse F3 is good. F3 should be a 2 ampere rating and on some early units it may be found that a 1 amp fuse has blown, allowing the battery to run down.
2. The charge rate of all units is approximately 4-6 amperes. Even if the battery were to be almost depleted, a period of 5 hours in standby would return a battery to almost full charge.
3. Under normal microcircuit welding conditions (flatpacks at settings of .75 volts and 5-10 milliseconds) or thin films (at .50 volts and 300 milliseconds), the level of charge will always remain at maximum.

   During operating at these typical weld settings and assuming a duty cycle not in excess of 1800 welds per hour, the charger will automatically replace amp hours of energy at the same rate that it is consumed.

4. If a battery is known to be completely discharged, it should be returned to the factory for a complete recharge conditioning cycle.

GENERAL TROUBLE SHOOTING

Symptom	Most Probably Fault Area
Double or multiple pulse	Contact bounce in actuator. Replace micro-switch.
Power at electrodes with Welder Power OFF	One or more of Power Transistors partially or completely failed. Replace. See Note No. 1.
Power at Electrodes with Welder Power ON but with actuator OPEN. Minimal Voltage Control	Q8 and/or Q9 defective. Replace.
Excessive Power at Electrodes during weld. No control with Weld Voltage.	Q7 defective. Replace
Power at electrodes with Welder Power ON and with Actuator Open or Closed. Voltage Control operational.	Q5 defective. Replace
Weld Pulse completes selected Weld Duration even though actuator opened immediately after start of pulse.	Q4 defective. Replace. Note: Q4 function is to terminate pulse with release of actuator regardless of selected Weld duration. This serves as a degree of protection of work between the electrodes where through error an excessive Weld Duration has been selected. Where this endpulse-with-actuator feature is not necessary or desired, Q4 can simply be removed from its socket.
Weld Duration continues beyond selected duration as long as Actuator held closed. Voltage control operational.	Q6, Q3, or Q2 defective or not seated properly in socket. Check. Replace where necessary.
No output	Q2 defective.

NOTE 1: In above symptoms the expression "Power at Electrodes" is used to indicate a FAULT condition as the mere presence of "Voltage" at the electrodes is a normal condition. In the power OFF condition and with a properly operating unit, a voltmeter placed across the Welder Output terminals will indicate a voltage of approximately 5 volts depending to

some extent on the resistance of the voltmeter. In a properly operating unit with Power OFF a milliameter placed across the out-out terminals of the welder will indicate a current flow in the order of three or four milli-amperes.

The "Power at Electrodes" indicates a condition where current in the order of several to possibly more than a thousand amperes may be available at the electrodes under varying degrees of fault conditions.

1. It is probable where under a Fault condition excessive current has been drawn that one or more of the Emitter leads of the Power Transistors has charred or burned. These insulated Emitter leads serve as equalizing resistors in addition to their role as connectors to the common Emitter Bar. Therefore, where replacement of these leads becomes necessary, they should be replaced with leads of the same gauge and length as the original.

DETAILED TROUBLE SHOOTING

CAUTION: DO NOT USE OHMETER TO TROUBLE-SHOOT WHILE POWER IS APPLIED

Symptom: Excessive heat at Weld Head Electrodes, evidenced by burning of material with little or no control from Weld Amplitude Selector.

There are four general areas where malfunction could produce this symptom. Listed below are these general areas in most probable order of occurrence:

1. Power Transistor Assembly.
2. Feed-Back wires to Weld Head. Note: This would be prime suspect where any work or replacement of head had been made just prior to development of symptom.
3. Driver Transistor Assembly.
4. Plug-in Printed Circuit Board.

A series of relatively simple elimination procedures will establish the area of the malfunction.

1. Eliminating Power Transistor Assembly. Procedure:

   (a) Turn Welder Power OFF.
   (b) Leave Weld Head and Actuator Cables in place.
   (c) Temporarily connect a flash-light bulb across weld head electrodes. (A 3.2 volt .15 ampere bulb will be satisfactory.) If there is ANY degree of illumination visible, the fault condition is in the Power Transistor Assembly. This Assembly must be removed and the defective Power Transistor(s) replaced. It is recommended that a complete replacement be made.
   (d) Note: Under NORMAL conditions with Welder Power OFF a Voltmeter placed across the Welder Output Terminals will read approximately 5 volts due to normal leakage of transistors in the circuit. Under these NORMAL conditions, the maximum current which can flow with a shorted output is in the order of about 15-20 milliamperes.
   (e) Note: Under a FAULT condition, voltage across the Welder Output will be approximately the same as (d) above. However, the maximum current which can flow under shorted output conditions can be over a thousand amperes for a short period of time.
   (f) Elimination procedure continues with the assumption that (c) above produced no indication of current flow.

2. Eliminating Feed-Back Wires to Weld Head. Procedure:

   (a) Leave flash-light connected as in 1(c) above.
   (b) Leave weld head and actuator cables in place.
   (c) Momentarily turn Welder Power ON. If flash-light bulb illuminates, turn Welder Power OFF.
   (d) Remove voltage fire plug from welder receptacle.
   (e) Loosen both sensing wires from weld head electrode assembly and lift free.
   (f) Disconnect weld head from output of welder.
   (g) Using an Ohmmeter, determine which electrode terminates at the NEGATIVE output terminal of the welder. Mark this electrode Negative. Do the same thing to the electrode which terminates at the POSITIVE output terminal of the welder.
   (h) Using the Ohmmeter with one lead connected to (2) of P-1 and the other alternately touching the two sensing wires listed from the weld head electrodes, connect the sensing wire which shows continuity with terminal (2) of P-1 to the weld head electrode marked NEGATIVE in Step 2g above.
   (i) Transfer Ohmmeter lead to terminal (1) of P-1 and check continuity with remaining sensing wire. Connect this sensing wire to the POSITIVE electrode as determined in Step 2g above.
   (j) Note: A strong possibility of error exists where flexible leads are used from welder output to weld head, or where a weld head other than the Hughes VTA-66 is used.
   (k) Note: Any suitable weld head may be employed with this welder. However, proper connection of the sensing wires MUST be observed.
      Sensing wire from terminal (2) of P-1 MUST go to the weld head electrode which terminates at the NEGATIVE output terminal of welder.
      Sensing wire from terminal (1) of P-1 MUST go to the weld head electrode which terminates at the POSITIVE output terminal of welder.
   (l) Elimination procedure continues with assumption that the sensing wires were found to have continuity and were properly connected to the weld head.

3. Eliminating Driver Transistor Assembly. Procedure:

   (a) Remove power from welder and remove welder

from cabinet.

(b) Disconnect battery cable from Positive terminal of battery. Tape end and set aside. Reconnect the lugged red/white wire to the positive battery terminal. This wire supplies the charging current to the batteries.

(c) Inspect for any visible signs of overheating.

(d) Remove Q-14 Emitter lead (gray wire on two lug terminal strip on top of power transistor plate).

(e) Connect Oscilloscope input leads across R-39 (the center 10 ohm resistor). Connect the Scope common to the side of the resistor having the gray common wire.

(f) Adjust Scope controls for:
Time/Div of 2 milliseconds
Volts/Div for .1 volt for a ten line grid or a full scale of 1 volt
Scope trace on upper grid line

(g) Adjust welder controls as follows:
Weld Duration: 2.0 Milliseconds
Weld Voltage: .5 Volts

(h) Connect Test Plug to J-1 welder. Connect the wire from (1) of test plug to POSITIVE output terminal of welder. Connect the wire from (2) of test plug to the stand-off insulator mentioned in (d) above.
THESE ARE THE SENSING WIRES AND MUST BE CONNECTED.

(i) While observing trace on Scope, turn welder power momentarily ON. Trace normally will drop about .003 volts and remain steady at that point. If trace drop exceeds this value, turn welder power OFF. Remove printed circuit board from the unit. Again while observing trace, turn welder power ON. If trace drops more than about .09 volts negative, it indicates a fault in either of the 2N2137 Driver Transistors. Turn welder power OFF. Move Scope input to across R38 (the 100 ohm 2W adjacent to R39). Turn power ON. Scope should indicate not more than .2 volts negative. Partial or complete failure of one or both of the 2N2137 Transistors will produce voltage readings other than given here. These two transistors can be replaced without further disassembly by removing the two retaining screws on each of the transistors and lifting them from their sockets. Exercise care in replacing these units. Make certain that the mica insulating washer is in place and after inserting new transistors in the sockets and securing the retaining screws, check for possible short by connecting an Ohmmeter between retaining screw and welder chassis. There should be NO continuity.

(j) Eliminating procedure continues on assumption that in 3(i) above with the printed circuit board removed from the unit, the voltage readings obtained on the scope did not differ greatly from those indicated for a normal operating unit. This places the remaining area of fault in the printed circuit board.

4. Printed Circuit Board Check-Test. Procedure:

(a) Test conditions:
1. Welder removed from cabinet. Power OFF.
2. Battery Cable disconnected from positive terminal of battery. Leave red/white wire connected to battery.
3. Remove Q-14 Emitter Lead (gray wire on two lug terminal strip on top of power transistor plate).
4. Connect Oscilloscope input across R39 (the center 10 ohm resistor). Connect the Scope common to the side of the resistor having the gray wire.
5. Adjust Scope controls for:
Time/Div of 2 Milliseconds
Volts/Div for .1 volt for a ten line grid or a full scale of 1 volt.
6. Set Welder controls as follows:
Weld Duration: 2.0 Milliseconds
Weld Voltage: .5 Volts
7. Connect the Test Plug to J-1 of welder. Connect the wire from (1) of the Test Plug to POSITIVE output terminal of welder. Connect the wire from (2) of Test Plug to lugged orange wire remaining at stand-off insulator mentioned above.
THESE ARE THE SENSING WIRES AND MUST BE CONNECTED.

(b) While observing trace on Scope, turn welder power momentarily ON. Trace will normally drop about .003 volts and remain steady at that point.

(c) If in (b) above the trace dropped more than .003 and remains deflected, operate the Weld Voltage Control and determine whether this has any effect. If the Weld Voltage Control has no effect, either Q8 and/or Q9 may be defective. If the Weld Voltage does show control, it is more likely that Q5 is defective.

(d) Having corrected fault condition indicated in (c) above, turn Welder Power ON. Trace on Scope should remain at point indicated in 4(b).

(e) Operate actuator. A negative going pulse of .5 volts in amplitude with a time base of approximately 2 milliseconds should be seen on Scope.

(f) Set Welder Voltage control to 1.5 volts. Scope should now show a 1.5 volt pulse. If the voltages obtained are in excess or less than the .5 and 1.5 selected, recalibration of the voltage stepping controls can be accomplished by alternately adjusting the two trimpots on the circuit board. The 200 ohm pot sets the minimum and the 1,000 ohm sets the maximum. There is some inter-action between these two adjustments; therefore, the high and low adjustments should be repeated as often as necessary to make the output coincide with Weld Voltage Selector.

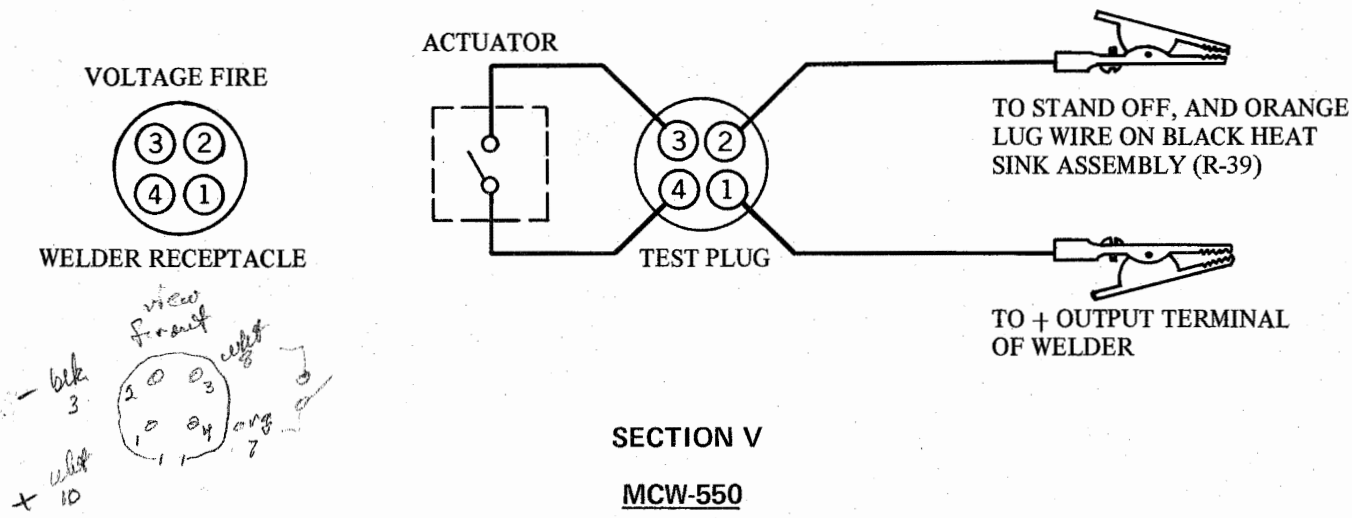
(g) Set Weld Duration to 1.0 second. Adjust Scope to present a 1.0 second pulse. With Weld Voltage Control set at .5 volts, close the actuator and hold closed while observing trace complete the 1.0 second pulse. Operate actuator again but release immediately. Trace as viewed on scope should immediately terminate when actuator is released. Trace should return to the no-signal level without hesitation. If the pulse does not immediately terminate without actuator but instead drops to some

intermediate point and then finally cuts off at the end of the 1.0 second, it is most probable that Q4 is partially defective or developing excessive leakage and should be replaced.

CAUTION!!!

The sensing wires MUST, MUST be properly connected AT ALL TIMES either when the unit is in normal operation or when any tests or adjustments are being made. In ALL of the test procedures outlined above, the sensing wires from the test plug have been connected as indicated in the various steps.

SUGGESTED TEST PLUG ACTUATOR:



SECTION V

MCW-550

DUTY CYCLE CAPABILITIES

The following table shows various examples of weld voltage and durations with the resultant weld circuit amperes and possible duty cycles based upon continuous 8 - 16 hour production days.

In many cases for short periods of time, these duty cycles can be considerably increased. It is particularly true when welding for durations less than 20 milliseconds.

With TWO MILLIOHM Load

WELD VOLTAGE	WELD DURATION	AMPERES	DUTY CYCLE
.75	5 MS	400	120 Welds per minute
1.00	10 MS	495	60 Welds per minute
1.00	20 MS	495	30 Welds per minute
1.35	5 MS	675	90 Welds per minute

With FIVE MILLIOHM Load

.22	100 MS	50	30 Welds per minute
.22	500 MS	50	20 Welds per minute
.22	1 Sec.	50	10 Welds per minute
.22	2 Sec.	50	5 Welds per minute
.22	3 Sec.	50	3 Welds per minute

** All Currents measured with 150 ampere/50 millivolt shunt in series with load.*

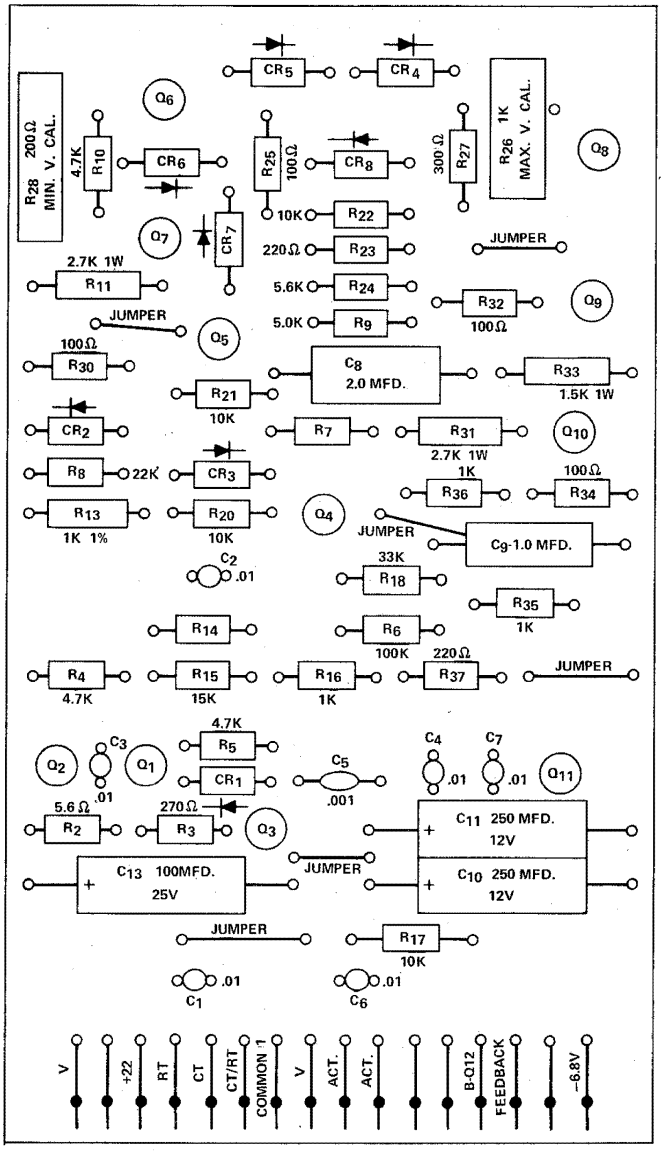
SECTION VI

MCW-550

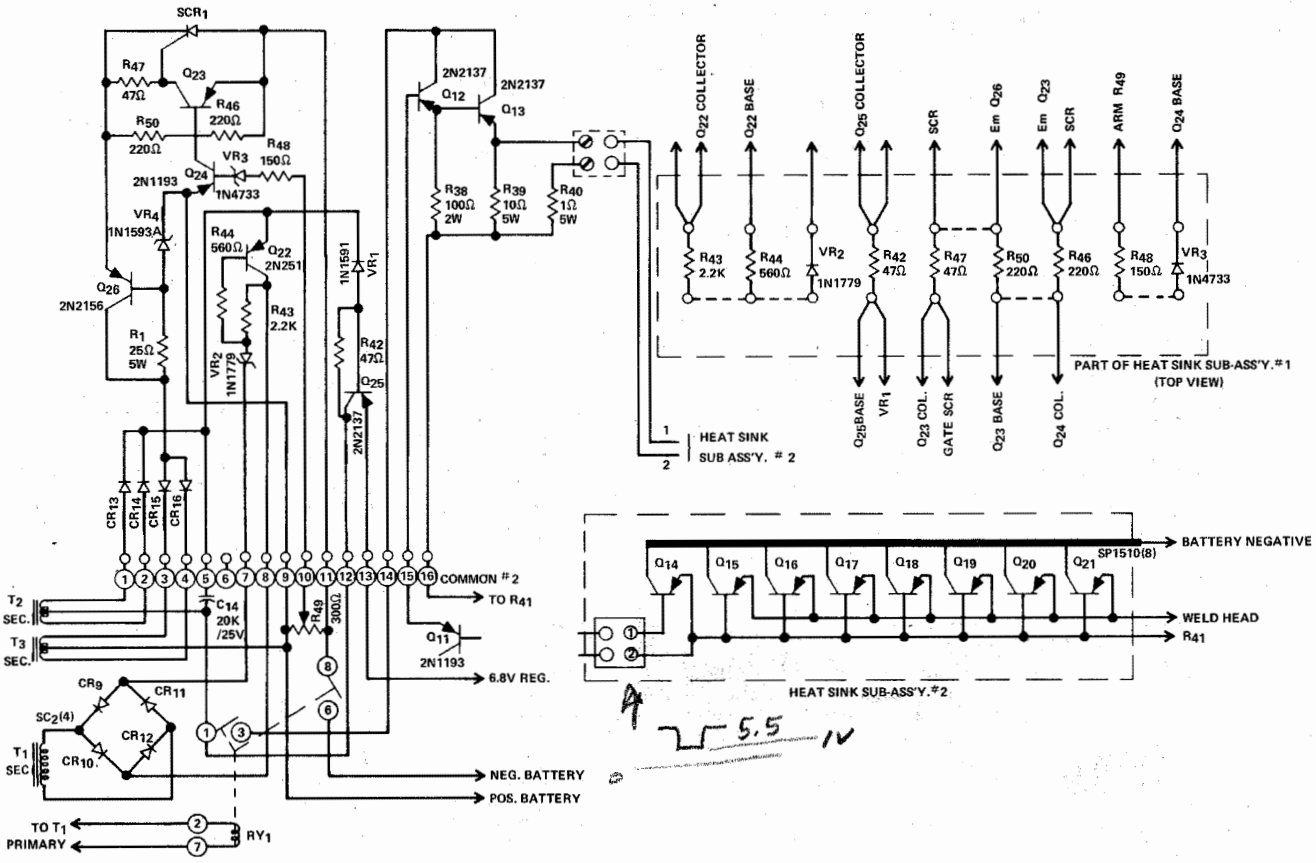
SCHEMATIC & PARTS LIST

Drawings & Prints Included

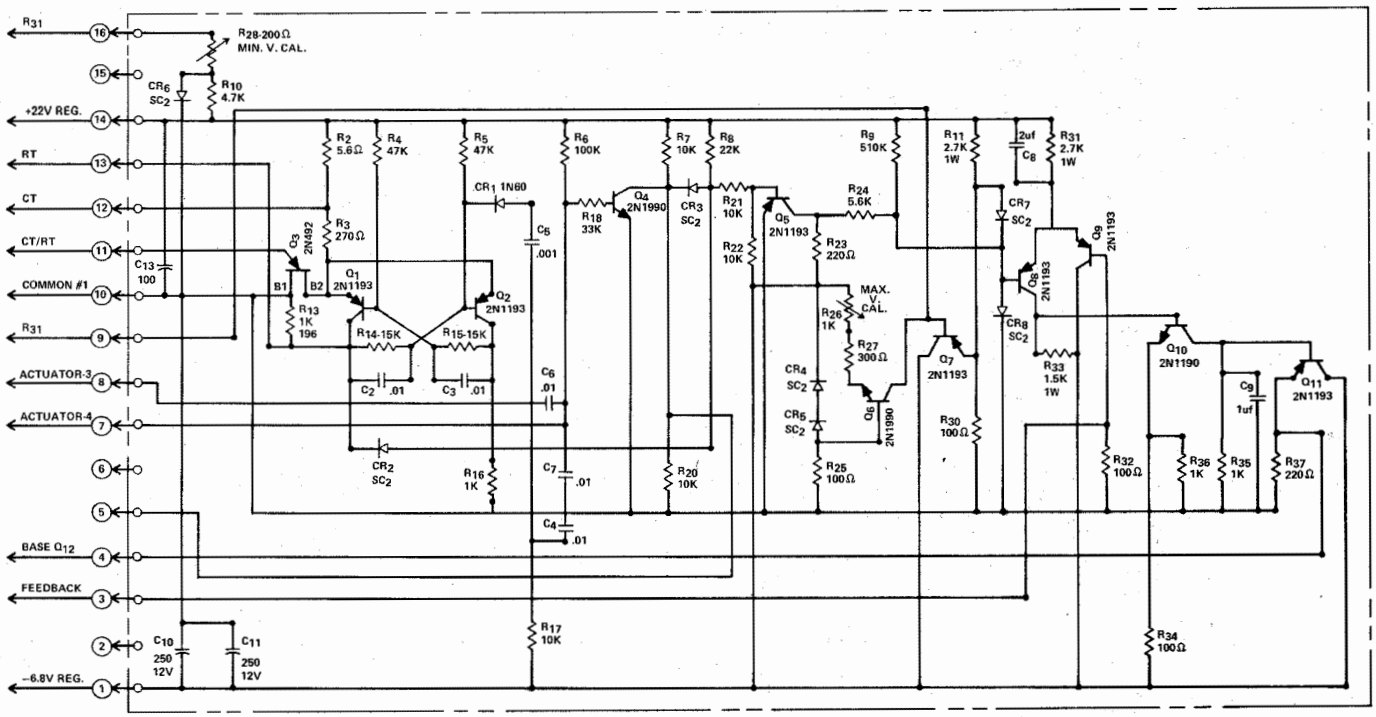
Number	Title
WD-2091 Sheet 1,2	Schematic MCW550 & Parts List
WD-2108	Schematic Diagram - Heat Sink Subassemblies
WD-2109	Schematic Diagram - Plug In Circuit Board
WD-2110	Circuit Board Layout
WD-2091 Sheet 3,4,5,6	Parts List - MCW-550
WD-2308	Block Diagram - MCW-550



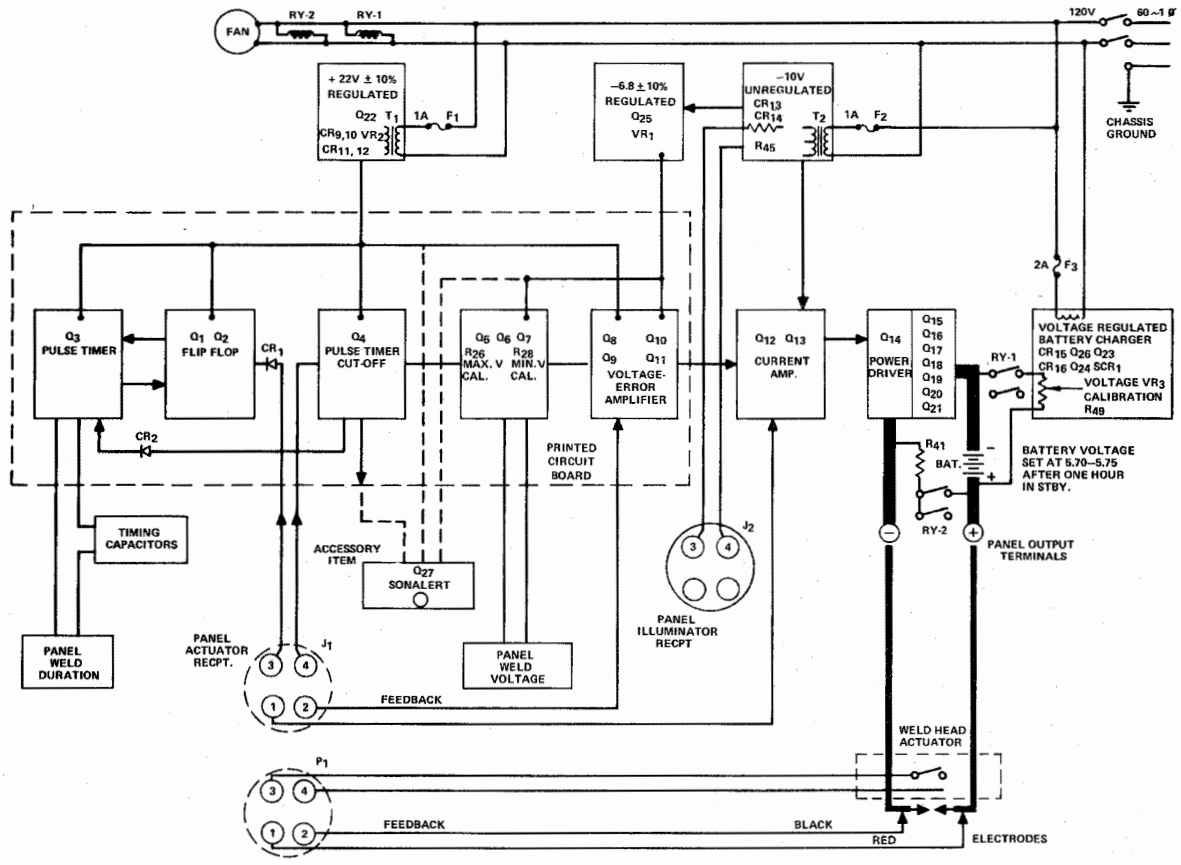
WD 2100
CIRCUIT BOARD COMPONENT LAYOUT



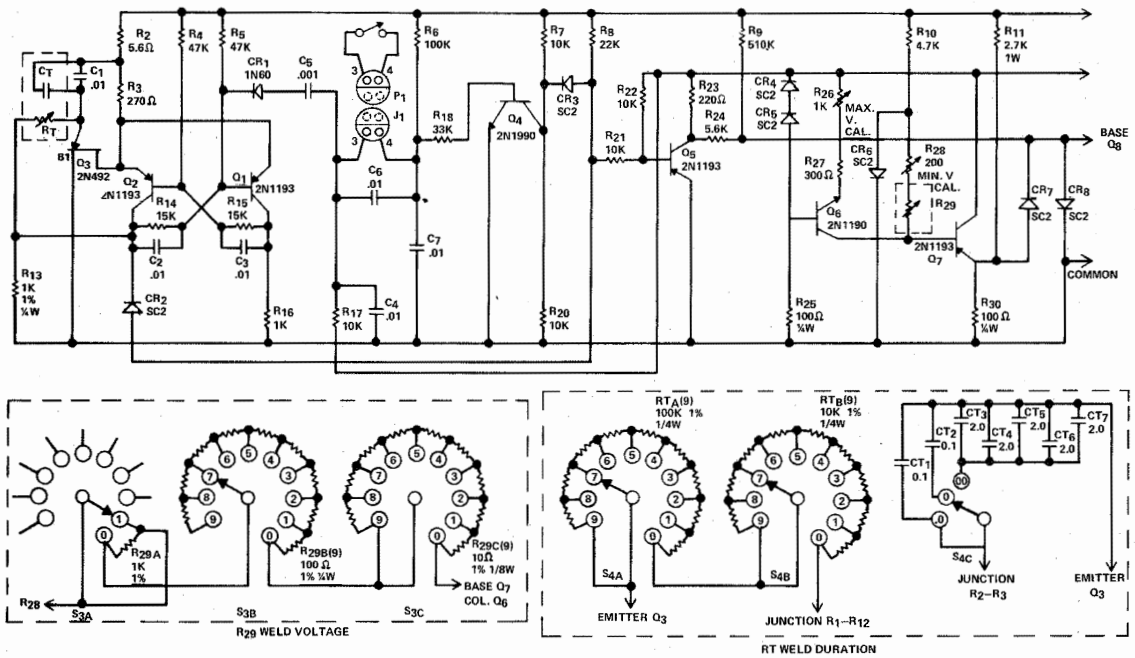
WD 2108
SCHEMATIC DIAGRAM – HEAT SINK SUB-ASSEMBLIES



WD 2109
SCHEMATIC DIAGRAM PLUG-IN CIRCUIT BOARD



WD 2308
MCW-550 BLOCK DIAGRAM

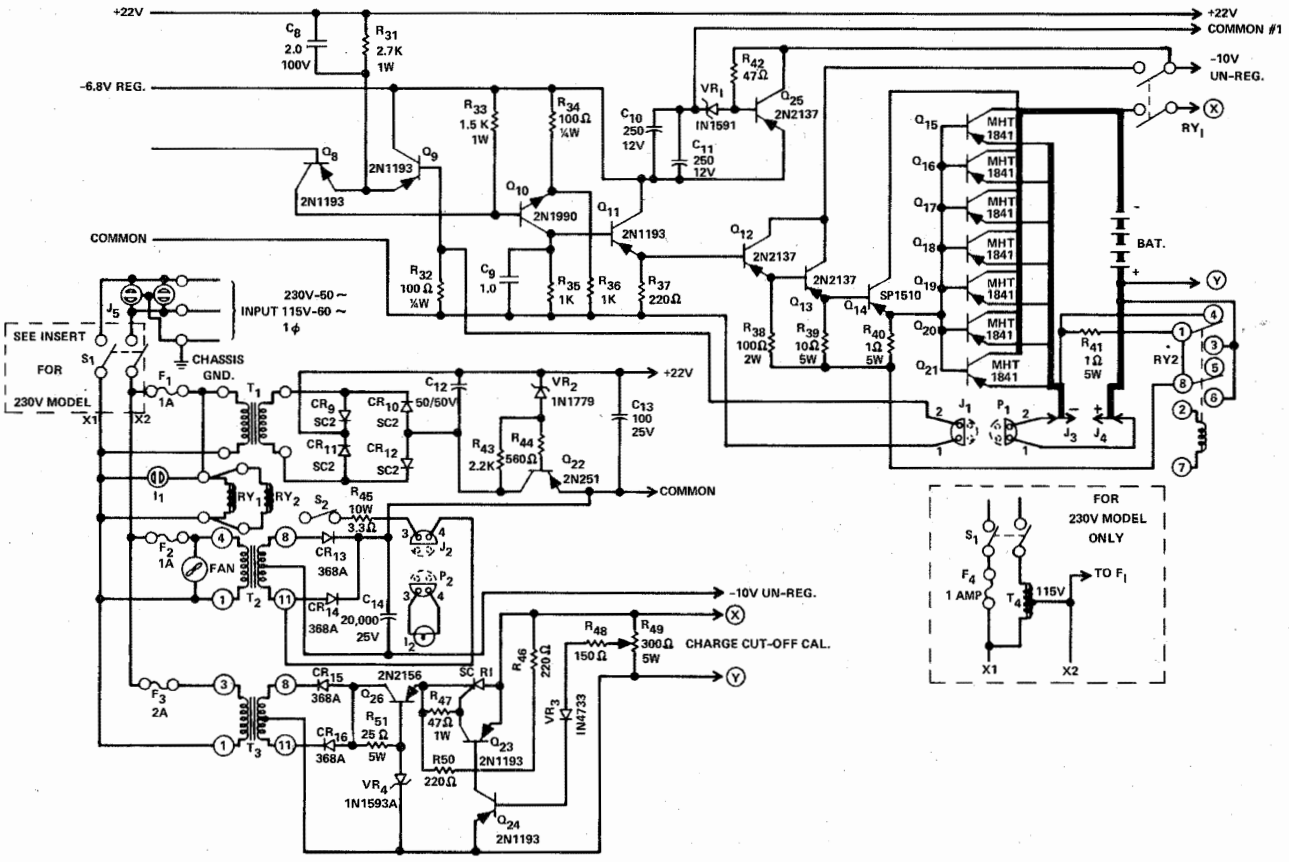


NOTE:

1 ALL CAPACITORS DESIGNATED IN MICROFARADS.

2 ALL FIXED RESISTORS ½ WATT UNLESS OTHERWISE SPECIFIED.

WD 2091
SCHEMATIC MCW-550



WD 2091
SCHEMATIC MCW-550

SYMBOL	DESCRIPTION	HAC PART NO.	VALUE		
R_2	Resistor, Fixed, Composition	590H176	5.6 OHM	1/2W	5%
R_3	Resistor, Fixed, Composition	590H181	270 OHM	1/2W	5%
R_4,R_5	Resistor, Fixed, Composition	590H191	47K	1/2W	5%
R_6	Resistor, Fixed, Composition	590H192	100K	1/2W	5%
R_7,R_{17},R_{20}, ,R_{21},R_{22}	Resistor, Fixed, Composition	590H188	10K	1/2W	5%
R_8	Resistor, Fixed, Composition	590H194	22K	1/2W	5%
R_9	Resistor, Fixed, Composition	590H193	510K	1/2W	5%
R_{10}	Resistor, Fi xed, Composition	590H186	4.7K	1/2W	5%
R_{11},R_{31}	Resistor, Fixed, Composition	590H202	2.7K	1W	5%
R_{13}	Resistor, Fixed, Metal Film	590H196	1K	1/4W	1%
R_{14},R_{15}	Resistor, Fixed, Composition	590H189	15K	1/2W	5%
R_{16},R_{35},R_{36}	Resistor, Fixed, Composition	590H184	1K	1/2W	5%
R_{18}	Resistor, Fixed, Composition	590H204	33K	1/2W	5%
R_{23},R_{37},R_{46}, R_{50}	Resistor, Fixed, Composition	590H180	220 OHM	1/2W	5%
R_{24}	Resistor, Fixed, Composition	590H187	5.6K	1/2W	5%
R_{25},R_{30},R_{32}, R_{34}	Resistor, Fixed, Composition	590H195	100 OHM	1/4W	5%

SYMBOL	DESCRIPTION	HAC PART NO.	VALUE		
R_{27}	Resistor, Fixed, Composition	590H182	300 OHM	1/2W	5%
R_{29A}	Resistor, Fixed, Metal Film	590H184	1K	1/2W	1%
R_{29B}(9)	Resistor, Fixed, Metal Film	590H195	100 OHM	1/4W	1%
R_{29C}(9)	Resistor, Fixed, Metal Film	590H199	10 OHM	1/8W	5%
RT_B(9)	Resistor, Fixed, Metal Film	590H197	10K	1/4W	1%
RT_A(9)	Resistor, Fixed, Metal Film	590H198	100K	1/4W	1%
R_{33}	Resistor, Fixed, Composition	590H201	1.5K	1W	5%
R_{39}	Resistor, Fixed, Wire-Wound	590H159	10 OHM	5W	
R_{40},R_{41}	Resistor, Fixed, Wire-Wound	590H160	1 OHM	5W	
R_{43}	Resistor, Fixed, Composition	590H185	2.2K	1/2W	5%
R_{44}	Resistor, Fixed, Composition	590H183	560 OHM	1/2W	5%
R_{45}	Resistor, Fixed, Wire-Wound	590H203	3.0 OHM	10W	
R_{47},R_{42}	Resistor, Fixed, Composition	590H178	47 OHM	1/2W	5%
R_{48}	Resistor, Fixed, Composition		150 OHM	1/2W	5%
R_{49}	Potentiometer, Wire-Wound	520H027	300 OHM	5W	
R_{26}	Potentiometer, 15 Turn Wire-Wound	520H029	1K	1/2W	
R_{28}	Potentiometer, 15 Turn Wire-Wound	520H028	200 OHM	1/2W	
R_{38}	Resistor, Fixed, Composition	520H073	100 OHM	2W	5%
R_{51}	Resistor, Fixed, Wire-Wound	590H205	25 OHM	5W	
C_1,C_2,C_3,C_4, C_6,C_7	Capacitor, Tubular, Mylar	200H053	.01 MFD	50V	±10%
C_5	Capacitor, Disc Ceramic	200H054	.001 MFD	500V	±10%
C_8	Capacitor, Metalized Mylar	200H057	2 MFD	100V	10%
C_9	Capacitor, Metalized Mylar	200H056	1 MFD	100V	10%
C_{10},C_{11}	Capacitor, Tubular, Electrolytic	200H058	250 MFD	12V	
C_{12}	Capacitor, Tubular, Electrolytic	200H059	50 MFD	50V	
C_{13}	Capacitor, Tubular, Electrolytic	200H060	100 MFD	25V	
C_{14}	Capacitor, Tubular, Electrolytic	200H061	20K MFD	25V	
CT_1	Capacitor, Tubular, Mylar	200H012	.1 MFD	100V	10%
CT_2	Capacitor, Tubular, Mylar	200H026	1 MFD	100V	10%
CT_3,CT_4,CT_5, CT_6,CT_7	Capacitor, Tubular, Mylar	200H028	2 MFD	100V	10%
F_1,F_2	Fuse, 1 AMP - AGC	310H027			
F_3	Fuse, 2 AMP - AGC	310H029			
I_1	Pilot Lamp, NEON	420H017			
J_1	Receptacle, 4 Pin, Male	550H020			
J_2	Receptacle, 4 Pin, Female	550H002			
J_3,J_4	Output Receptacles	WD 2042			
J_5	Power Outlet and Receptacle	550H021			

SYMBOL	DESCRIPTION		HAC PART NO.	
RY_1	Relay, Power, DPDT 10 AMP, 115 VAC Coil		580HO44	
RY_2	Relay, Power, DPDT 5 AMP, 115 VAC Coil		580H027	
S_1	Switch, Power, DPST, 15A-125V		720H001	
S_2	Switch, Power, DPST, 15A-125V		720H001	
S_{3A},S_{3B},S_{3C}	Switch, Thumbwheel (voltage)		720H059	
S_{4A},S_{4B},S_{4C}	Switch, Thumbwheel (duration)		720H060	
T_1	Transformer, Power (F90X)		750H074	
T_2,T_3	Transformer, Power (RT-204)		750H073	
Fan	Muffin, Venturi		260H001	
Bat.	Nickel Cadmium Cells (4)		118H001	(4)
CR_1	Diode	IN60	560H027	
$CR_{2\text{-}12}$	Rectifier 1 AMP 200V		560H010	
$CR_{13\text{-}16}$	Rectifier 15 AMP 50V		560H029	
SCR_1	Silicon Rectifier	2N1842	560H025	
Q_1,Q_2,Q_5,Q_7,Q_8, Q_9,Q_{11},Q_{23},Q_{24}	Transistor	2N1193	560H020	
Q_3	Transistor, Unijunction	2N1671A	560H071	
Q_4,Q_6,Q_{10}	Transistor	2N1990	560H022	
Q_{12},Q_{13},Q_{25}	Transistor	2N2137	560H023	
$Q_{14\text{-}21}$	Transistor Power (Special)		560H018	
Q_{22}	Transistor	2N251	560H021	
Q_{26}	Transistor	2N2156	560H031	
VR_1	Zener Diode	1N1591A	560H026	
VR_2	Zener Diode	1N1779	560H028	
VR_3	Zener Diode	1N4733	560H115	
VR_4	Zener Diode	1N1593A	560H030	

FOR 230 VOLT MODELS ONLY

T_4	Transformer, 230V; 115V Stepdown 50 - 60 cycles 100 watts (Allied 62G557)		750H064
F_4	Fuse, 1 AMP - AGC		310H027

NOTES

Gates
820-0064W
6V
20AH
Sealed Rechargeable Battery

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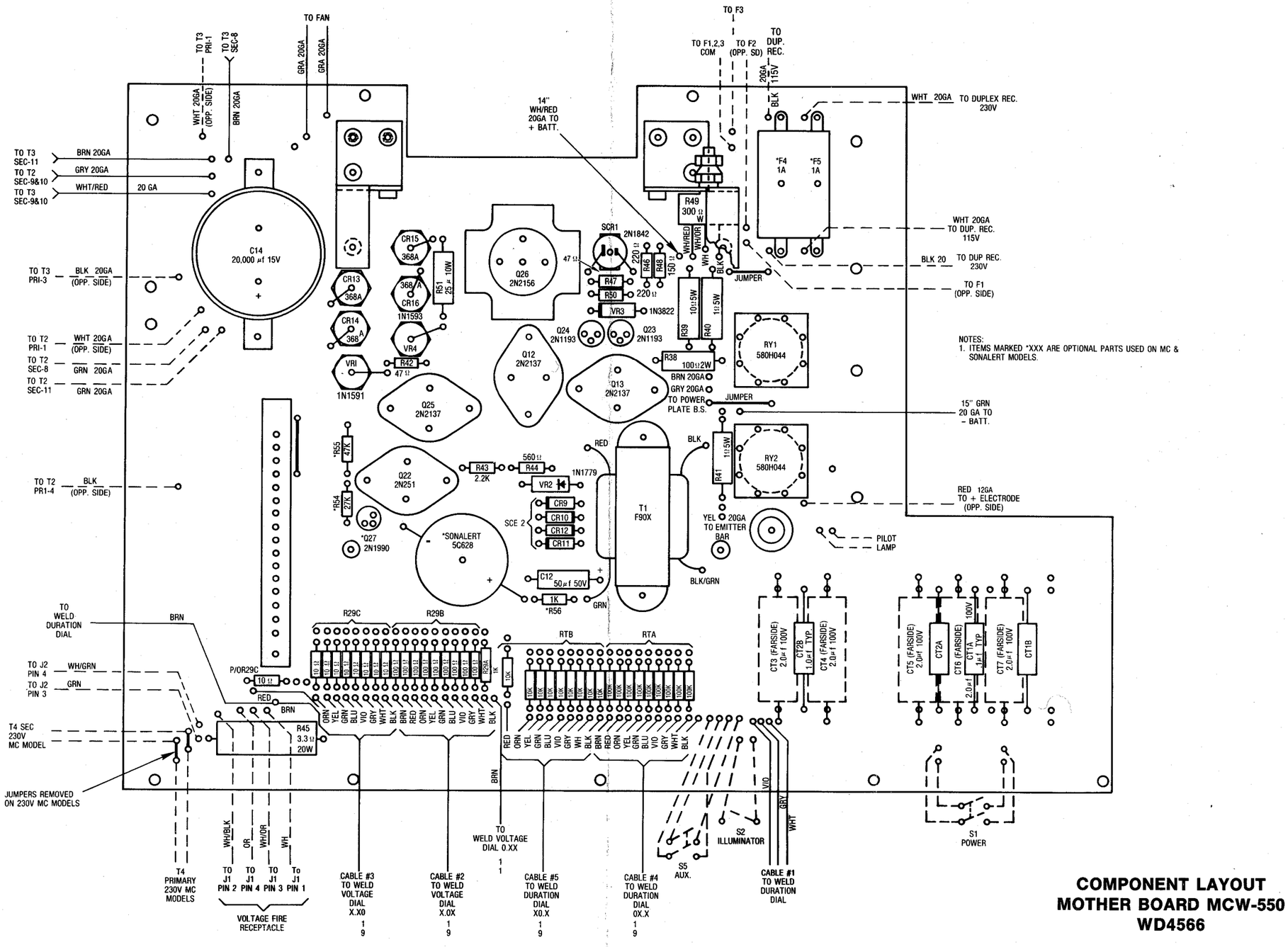

COMPONENT LAYOUT
MOTHER BOARD MCW-550
WD4566